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TITLE: METHOD AND SYSTEM FOR PROVIDING AUTOMATED VEHICLE DIAGNOSTIC FUNCTION UTILIZING A TELEMATICS UNIT

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METHOD AND SYSTEM FOR PROVIDING AUTOMATED VEHICLE DIAGNOSTIC FUNCTION UTILIZING A TELEMATICS UNIT

FIELD OF THE INVENTION

This invention relates generally to wireless communications with a mobile vehicle. More specifically, the invention relates to a method and system for providing automated vehicle diagnostic function utilizing a telematics unit within a telematics equipped mobile vehicle.

BACKGROUND OF THE INVENTION

The opportunity to utilize wireless features in a mobile vehicle is ever increasing as the automobile is being transformed into a communications and entertainment platform as well as a transportation platform. Wireless features include wireless vehicle communication and networking services for a mobile vehicle.

Typically, wireless systems within mobile vehicles (e.g. telematics units) provide voice communication. Recently, these wireless systems have been utilized to update systems within telematics units, such as, for example radio station presets.

Conventional diagnostic applications require the use of scarce or expensive technician assists to detect or recreate problems occurring within a mobile vehicle. The present invention advances the state of the art in telematics equipped mobile vehicles.

SUMMARY OF THE INVENTION

One aspect of the invention includes a method for providing automated vehicle diagnostic function within a mobile vehicle communication system. The method includes configuring a primary diagnostic script for a telematics equipped mobile vehicle, providing the primary diagnostic script to the mobile vehicle, executing the primary diagnostic script, and collecting diagnostic data based on the executed primary diagnostic script.

In accordance with another aspect of the invention, a computer readable medium storing a computer program includes: computer readable code for configuring a primary diagnostic script for a telematics equipped mobile vehicle; computer readable code for providing the primary diagnostic script to the mobile vehicle; computer readable code for executing the primary diagnostic script; and computer readable code for collecting diagnostic data based on the executed primary diagnostic script.

In accordance with yet another aspect of the invention, a system for automated vehicle diagnostic function is provided. The system includes means for configuring a primary diagnostic script for a telematics equipped mobile vehicle. Means for providing the primary diagnostic script to the mobile vehicle is provided. Means for executing the primary diagnostic script and means for collecting diagnostic data based on the executed primary diagnostic script is also provided.

The aforementioned, and other features and advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims and equivalents thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an operating environment for implementing wireless communication within a mobile vehicle communication system;

FIG. 2 is a block diagram of telematics based system in accordance with an embodiment of the present invention; and

FIG. 3 is a flow diagram of one embodiment of a method of providing automated vehicle diagnostic function utilizing a telematics unit, in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates one embodiment of system for data transmission over a wireless communication system, in accordance with the present invention at **100**. Mobile vehicle communication system (MVCS) **100** includes a mobile vehicle communication unit (MVCU) **110**, a vehicle communication network **112**, a telematics unit **120**, one or more wireless carrier systems **140**, one or more communication networks **142**, one or more land networks **144**, one or more client, personal or user computers **150**, one or more web-hosting portals **160**, and one or more call centers **170**. In one embodiment, MVCU **110** is implemented as a mobile vehicle equipped with suitable hardware and software for transmitting and receiving voice and data communications. MVCS **100** may include additional components not relevant to the present discussion. Mobile vehicle communication systems and telematics units are known in the art.

MVCU **110** may also be referred to as a mobile vehicle throughout the discussion below. In operation, MVCU **110** may be implemented as a motor vehicle, a marine vehicle, or as an aircraft. MVCU **110** may include additional components not relevant to the present discussion.

MVCU **110**, via a vehicle communication network **112**, sends signals to various units of equipment and systems (detailed below) within MVCU **110** to perform various functions such as unlocking a door, opening the trunk, setting personal comfort settings, and calling from telematics unit **120**. In facilitating interactions among the various communication and electronic modules, vehicle communication network **112** utilizes network interfaces such as controller-area network (CAN), International Organization for Standardization (ISO) Standard 9141, ISO Standard 11898 for high-speed applications, ISO Standard 11519 for lower speed applications, and Society of Automotive Engineers (SAE) Standard J1850 for high-speed and lower speed applications.

MVCU **110**, via telematics unit **120**, sends to and receives radio transmissions from wireless carrier system **140**. Wireless carrier system **140** is implemented as any suitable system for transmitting a signal from MVCU **110** to communication network **142**.

Telematics unit **120** includes a digital signal processor (DSP) **122** connected to a wireless modem **124**, a global positioning system (GPS) unit **126**, an in-vehicle memory **128**, a microphone **130**, one or more speakers **132**, and an embedded or in-vehicle mobile phone **134**. In other embodiments, telematics unit **120** may be implemented without one or more of the above listed components, such as, for example speakers **132**. Telematics unit **120** may include additional components not relevant to the present discussion.

In one embodiment, DSP **122** is implemented as a microcontroller, controller, host processor, or vehicle communications processor. In an example, DSP **122** is implemented as an application specific integrated circuit (ASIC). In another embodiment, DSP **122** is implemented as a processor working in conjunction with a central processing unit (CPU) performing the function of a general purpose processor. GPS unit **126** provides longitude and latitude coordinates of the vehicle responsive to a GPS broadcast signal received from

one or more GPS satellite broadcast systems (not shown). In-vehicle mobile phone **134** is a cellular-type phone, such as, for example an analog, digital, dual-mode, dual-band, multi-mode or multi-band cellular phone.

DSP **122** executes various computer programs that control programming and operational modes of electronic and mechanical systems within MVCU **110**. DSP **122** controls communications (e.g. call signals) between telematics unit **120**, wireless carrier system **140**, and call center **170**. In one embodiment, a voice-recognition application is installed in DSP **122** that can translate human voice input through microphone **130** to digital signals. DSP **122** generates and accepts digital signals transmitted between telematics unit **120** and a vehicle communication network **112** that is connected to various electronic modules in the vehicle. In one embodiment, these digital signals activate the programming mode and operation modes, as well as provide for data transfers. In this embodiment, signals from DSP **122** are translated into voice messages and sent out through speaker **132**.

Communication network **142** includes services from one or more mobile telephone switching offices and wireless networks. Communication network **142** connects wireless carrier system **140** to land network **144**. Communication network **142** is implemented as any suitable system or collection of systems for connecting wireless carrier system **140** to MVCU **110** and land network **144**.

Land network **144** connects communication network **142** to client computer **150**, web-hosting portal **160**, and call center **170**. In one embodiment, land network **144** is a public-switched telephone network (PSTN). In another embodiment, land network **144** is implemented as an Internet protocol (IP) network. In other embodiments, land network **144** is implemented as a wired network, an optical network, a fiber network, other wireless networks, or any combination thereof. Land network **144** is connected to one or more landline telephones. Communication network **142** and land network **144** connect wireless carrier system **140** to web-hosting portal **160** and call center **170**.

Client, personal or user computer **150** includes a computer usable medium to execute Internet browser and Internet-access computer programs for sending and receiving data over land network **144** and optionally, wired or wireless communication networks **142** to web-hosting portal **160**. Personal or client computer **150** sends user preferences to web-hosting portal through a web-page interface using communication standards such as hypertext transport protocol (HTTP), and transport-control protocol and Internet protocol (TCP/IP). In one embodiment, the data includes directives to change certain programming and operational modes of electronic and mechanical systems within MVCU **110**.

In operation, a client utilizes computer **150** to initiate setting or re-setting of user-preferences for MVCU **110**. In an example, a client utilizes computer **150** to provide radio station presets as user-preferences for MVCU **110**. User-preference data from client-side software is transmitted to server-side software of web-hosting portal **160**. User-preference data is stored at web-hosting portal **160**.

Web-hosting portal **160** includes one or more data modems **162**, one or more web servers **164**, one or more databases **166**, and a network system **168**. Web-hosting portal **160** is connected directly by wire to call center **170**, or connected by phone lines to land network **144**, which is connected to call center **170**. In an example, web-hosting portal **160** is connected to call center **170** utilizing an IP network. In this example, both components, web-hosting portal **160** and call center **170**, are connected to land network **144** utilizing the IP network. In another example, web-hosting portal **160** is connected to land network **144** by one or more data modems **162**. Land network **144** sends digital data to and from modem **162**, data that is then transferred to web server **164**. Modem **162** may reside inside web server **164**. Land network **144** transmits data communications between web-hosting portal **160** and call center **170**.

Web server **164** receives user-preference data from user computer **150** via land network **144**. In alternative embodiments, computer **150** includes a wireless modem to send data to web-hosting portal **160** through a wireless communication network **142** and a land network **144**. Data is received by land network **144** and sent to one or more web servers **164**. In one embodiment, web server **164** is implemented as any suitable hardware and software capable of providing web services to help change and transmit personal preference settings from a client at computer **150** to telematics unit **120** in MVCU **110**. Web server **164** sends to or receives from one or more databases **166** data transmissions via network system **168**. Web server **164** includes computer applications and files for managing and storing personalization settings supplied by the client, such as door lock/unlock behavior, radio station preset selections, climate controls, custom button configurations and theft alarm settings. For each client, the web server potentially stores hundreds of preferences for wireless vehicle communication, networking, maintenance and diagnostic services for a mobile vehicle.

In one embodiment, one or more web servers **164** are networked via network system **168** to distribute user-preference data among its network components such as database **166**. In an example, database **166** is a part of or a separate computer from web server **164**. Web server **164** sends data transmissions with user preferences to call center **170** through land network **144**.

Call center **170** is a location where many calls are received and serviced at the same time, or where many calls are sent at the same time. In one embodiment, the call center is a telematics call center, facilitating communications to and from telematics unit **120** in MVCU **110**. In an example, the call center is a voice call center, providing verbal communications between an advisor in the call center and a subscriber in a mobile vehicle. In another example, the call center contains each of these functions. In other embodiments, call center **170** and web-hosting portal **160** are located in the same or different facilities.

Call center **170** contains one or more voice and data switches **172**, one or more communication services managers **174**, one or more communication services databases **176**, one or more communication services advisors **178**, and one or more network systems **180**.

Switch **172** of call center **170** connects to land network **144**. Switch **172** transmits voice or data transmissions from call center **170**, and receives voice or data transmissions from telematics unit **120** in MVCU **110** through wireless carrier system **140**, communication network **142**, and land network **144**. Switch **172** receives data transmissions from and sends data transmissions to one or more web-hosting portals **160**. Switch **172** receives data transmissions from or sends data transmissions to one or more communication services managers **174** via one or more network systems **180**.

Communication services manager **174** is any suitable hardware and software capable of providing requested communication services to telematics unit **120** in MVCU **110**. Communication services manager **174** sends to or receives from one or more communication services databases **176** data transmissions via network system **180**. Communication services manager **174** sends to or receives from one or more communication services advisors **178** data transmissions via network system **180**. Communication services database **176** sends to or receives from communication services advisor **178** data transmissions via network system **180**. Communication services advisor **178** receives from or sends to switch **172** voice or data transmissions.

Communication services manager **174** provides one or more of a variety of services including enrollment services, navigation assistance, directory assistance, roadside assistance, business or residential assistance, information services assistance, emergency assistance, automated vehicle diagnostic function, and communications assistance. Communication services manager **174** receives service-preference requests for a variety of services from the client via computer **150**, web-hosting portal **160**, and land network **144**.

Communication services manager **174** transmits user-preference and other data such as, for example primary diagnostic script to telematics unit **120** in MVCU **110** through wireless carrier system **140**, communication network **142**, land network **144**, voice and data switch **172**, and network system **180**. Communication services manager **174** stores or retrieves data and information from communication services database **176**. Communication services manager **174** may provide requested information to communication services advisor **178**.

In one embodiment, communication services advisor **178** is implemented as a real advisor. In an example, a real advisor is a human being in verbal communication with a user or subscriber (e.g. a client) in MVCU **110** via telematics unit **120**. In another embodiment, communication services advisor **178** is implemented as a virtual advisor. In an example, a virtual advisor is implemented as a synthesized voice interface responding to requests from telematics unit **120** in MVCU **110**.

Communication services advisor **178** provides services to telematics unit **120** in MVCU **110**. Services provided by communication services advisor **178** include enrollment services, navigation assistance, real-time traffic advisories, directory assistance, roadside assistance, business or residential assistance, information services assistance, emergency assistance, automated vehicle diagnostic function, and communications assistance. Communication services advisor **178** communicate with telematics unit **120** in MVCU **110** through wireless carrier system **140**, communication network **142**, and land network **144** using voice transmissions, or through communication services manager **174** and switch **172** using data transmissions. Switch **172** selects between voice transmissions and data transmissions.

In operation, an incoming call is routed to telematics unit **120** within mobile vehicle **110** from call center **170**. In one embodiment, the call is routed to telematics unit **120** from call center **170** via land network **144**, communication network **142**, and wireless carrier system **140**.

FIG. 2 is a block diagram of a telematics based system in accordance with an embodiment of the present invention. **FIG. 2** shows a telematics based system **200** for providing automated vehicle diagnostic function utilizing a telematics unit within a telematics equipped mobile vehicle.

In **FIG. 2**, the system includes a mobile vehicle **210** having a telematics unit **220** coupled to one or more vehicle system modules **290** via a vehicle communication bus **212**, a service provider **270**, such as, for example a call center, a service center, and the like. Telematics unit **220** further includes a database **228** that contains programs **231**, vehicle diagnostic data **232**, data storage **233** and triggers **234**. Vehicle system module (VSM) **290** further includes a program **291**, test script data **292**. In one embodiment, VSM **290** is located within telematics unit **220**. Service provider **270** further includes an automated vehicle diagnostic function database **276** that contains programs **231**, data storage **273**, and triggers **274**. In **FIG. 2**, the elements are presented for illustrative purposes and are not intended to be limiting. Telematics based system **200** may include additional components not relevant to the present discussion.

Telematics unit **220** is any telematics device enabled for operation with a telematics service provider, such as, for example telematics unit **120** as described with reference to **FIG. 1**. Telematics unit **220** in vehicle **210** is in communication with service provider **270** (e.g. a "service center"). Telematics unit **220** includes volatile and non-volatile memory components for storing data and programs. In one embodiment, memory components in telematics unit **220** contain database **228**.

Database **228** includes one or more programs **231** for operating telematics unit **220**, such as, for managing a portion of an automated vehicle diagnostic system utilizing a telematics unit. In operation, program **231** receives primary diagnostic script from service provider **270** at data storage **233**. Program **231** executes the primary diagnostic script, such as, for example by parsing the primary diagnostic script, and collects diagnostic data responsive to the executed primary diagnostic script. In one embodiment, program **231** parses the primary diagnostic script and stores triggers at triggers **234** and transfers test data to VSM **290** for execution. In an example, program **231** executes the primary diagnostic script immediately upon reception of the primary diagnostic script. In another example, program **231** executes the primary diagnostic script at a predetermined time interval. In yet another example, program **231** executes the primary diagnostic script when a predetermined event occurs, such as, for example upon reception of a command from a user interface, such as, a voice command from a user or technician or a command received from an advisor at service provider **270**.

Vehicle system module (VSM) **290** is any vehicle system control module having software and hardware components for operating, controlling or monitoring one or more vehicle systems. In one embodiment, VSM **290** is a sensor and provides diagnostic data collected from mobile vehicle **210**. In another embodiment, VSM **290** is a global positioning system (GPS) module, such as, for example GPS unit **126** of **FIG. 1**, and provides location information to complement diagnostic data collected from mobile vehicle **210**. In yet another embodiment, VSM **290** is a controller for controlling a vehicle system such as, for example, PCM control modules, vehicle interior and exterior illumination, sentencing and diagnostic modules, body control modules and additionally provides diagnostic data collected from mobile vehicle **210.**

Vehicle system module **290** contains one or more processors, one or more memory devices and one or more connection ports. In one embodiment, VSM **290** includes a software switch for scanning received information, such as, for example sensor information to identify that data has been received. VSM **290** is coupled to a vehicle communication bus **212**, and therefore to any other device that is also coupled to vehicle communication bus **212**. The vehicle communication bus is also referred to as a vehicle communication network. In one embodiment, VSM **290** is directly coupled to telematics unit **220**, such as, for example vehicle communication bus **212** coupling telematics unit **220** to vehicle system modules **290**. In an example, vehicle communication bus **212** is a vehicle communication network **112** as described in **FIG. 1**, above. In another embodiment, VSM **290** is indirectly coupled to telematics unit **220**.

In operation, program **231** parses the primary diagnostic script and transfers test data to test script data **292** within VSM **290** for execution by program **291**. In one embodiment, program **291** executes the test data to diagnose existing trouble codes through vehicle interaction, such as, for example cycling power modes, modifying module settings, or other configurable parameters. In another embodiment, program **291** executes the test data to identify specific undesirable vehicle system operation by recreating sequences that cause known undesirable vehicle system operation in other similar vehicles. In yet another embodiment, program **291** executes the test data to collect diagnostic data related to intermittent undesirable vehicle system operation by triggering diagnostic data collection when defined conditions occur.

Service provider **270** is any service center providing telematics services such as service center **170** described with reference to FIG. 1. In one embodiment, service provider **270** includes hardware and software for managing database **276** as an automated vehicle diagnostic function database. In another embodiment, service center **270** is configured to access a database that is in another location but coupled to service center **270** such as, for example, database **166** in web server **160** as described in FIG. 1. Database **276** contains test and vehicle diagnostic data stored at data storage **273** and trigger event data stored at triggers **274**. In one embodiment, database **276** includes one or more programs **231** for managing vehicle update data, for managing software update processes for various vehicle systems, for responding to vehicle software update requests, and for providing automated vehicle diagnostic function. In another embodiment, database **276** is a relational database that includes information, such as, for example vehicle makes and models, vehicle system modules for the makes and models, individual vehicle identification numbers (VIN) and other vehicle identifiers, vehicle system software for providing automated vehicle diagnostic function, and trigger event data specifying conditions for providing automated vehicle diagnostic function. The trigger is, for example, identification of diagnostic routines by an adviser in communication with a customer supplying a request.

In operation, service provider **270** manages the configuring and delivery of primary diagnostic script to a telematics equipped vehicle (e.g. mobile vehicle **210**) within a mobile vehicle communication system (MVCS). In one embodiment, service provider **270** is enabled to concatenate, and otherwise manage, one or more diagnostic scripts providing automated vehicle diagnostic function to at least one mobile vehicle **210** within the MVCS. In operation, service provider **270** receives a request for automated vehicle diagnostic function from a user interface. In an example, service provider **270** receives a request for

automated vehicle diagnostic function from a user utilizing a user interface. In another example, service provider **270** receives a request for automated vehicle diagnostic function from a technician utilizing a user interface.

The request initiates an automated vehicle diagnostic function. In one example, the request initiates an automated vehicle diagnostic function utilizing a live adviser. In another example, the request initiates an automated vehicle diagnostic function utilizing a virtual adviser. The advisor identifies diagnostic routines based on the received request. In one example, the advisor identifies diagnostic routines by presenting high level questions to the client/technician and filters the answers to obtain one or more diagnostic scripts for mobile vehicle **210**. The diagnostic scripts are combined to produce a primary diagnostic script and provided to mobile vehicle **210** for execution.

FIG. 3 is a flow diagram of an embodiment of a method of providing automated vehicle diagnostic function utilizing a telematics unit within a telematics equipped mobile vehicle. In **FIG. 3**, method **300** may utilize one or more systems detailed in **FIGS. 1** and **2**, above. The present invention can also take the form of a computer usable medium including a program for configuring an electronic module within a vehicle. The program stored in the computer usable medium includes computer program code for executing the method steps described in **FIG. 3**. In **FIG. 3**, method **300** begins at step **310**.

At step **320**, a primary diagnostic script is configured for a telematics equipped mobile vehicle. In one embodiment, configuring the primary diagnostic script includes determining at least one diagnostic script based on diagnostic options and retrieving the at least one determined diagnostic script. In this embodiment, the one or more diagnostic scripts are combined into the primary diagnostic script. In an example, the primary diagnostic script recreates known problem sequences when executed. In another example, the primary diagnostic script triggers data capture when specific conditions exist. In yet another

example, configuring the primary diagnostic script is conducted as described in FIG. 2, above. In one embodiment, the primary diagnostic script is configured at the service provider.

At step **330**, the primary diagnostic script is provided to the mobile vehicle. In one embodiment, the primary diagnostic script is provided to the mobile vehicle utilizing a mobile vehicle communication system (MVCS). At step **340**, the primary diagnostic script is executed.

At step **350**, diagnostic data is collected based on the executed primary diagnostic script. In one embodiment, collecting diagnostic data based on the executed primary diagnostic script includes receiving diagnostic data from vehicle system modules and storing the received diagnostic data.

At step **360**, the method is terminated. In one embodiment, the method further includes analyzing the collected diagnostic data. In an example, the collected diagnostic data is analyzed within the telematics unit in the telematics equipped mobile vehicle. In another example, the collected diagnostic data is analyzed at the service provider. In another embodiment, the method further includes initiating the automated vehicle diagnostic function. In an example, initiating the automated vehicle diagnostic function includes receiving a request for automated vehicle diagnostic function from a user interface and identifying diagnostic routines based on the received request.

The above-described methods and implementation for providing automated vehicle diagnostic function utilizing a telematics unit within a telematics equipped mobile vehicle are example methods and implementations. These methods and implementations illustrate one possible approach for providing automated vehicle diagnostic function utilizing a telematics unit within a telematics equipped mobile vehicle. The actual implementation may vary from the method discussed. Moreover, various other improvements and modifications to this invention may occur to those skilled in the art, and those improvements and modifications will fall within the scope of this invention as set forth in the claims below.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive.

5